Publication number : 2000-093866

Date of publication of application : 04.04.2000

Int.Cl. B05C 5/00 B05D 1/26

Application number : 10-265184

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Date of filing : 18.09.1998

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[Abstract]

PROBLEM TO BE SOLVED: To facilitate the rapid adjustment of the coating quantity of paste to form a paste pattern having a desired shape with high precision.

SOLUTION: While changing the relative position relation of a nozzle 13a and an actual substrate 22, by discharging paste 23 from a discharge port of the nozzle 13a, a desired paste pattern is formed on the surface of an actual substrate 22. In this case, when the nozzle 13a reaches a position on the actual substrate 22 determined as a change point in advance, the distance for the surface of the actual substrate 22 to the paste discharge port of the nozzle 13a, that is, the coating height is changed from a

coating height 1 to a coating height 2 set in advance, and accordingly, paste discharge from the nozzle 13a is changed. In this way, coating paste thickness can be changed more quickly than changing of pressure applied to a paste housing cylinder provided with the nozzle 13a.

[Claims]

[Claim 1]

A paste coating method in which a substrate is disposed on a table so that the substrate corresponds with a discharge outlet of a nozzle, a predetermined distance is maintained between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is changed while discharging paste filled into a paste container box from the discharge outlet onto the substrate, thus patterning the paste pattern of a predetermined shape on the substrate,

wherein the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate is changed, and the paste having an amount proportional to the changed distance is discharged onto the substrate.

[Claim 2]

The paste coating method according to Claim 1, wherein the paste pattern patterned on the substrate is formed in a predetermined shape by changing the amount of variation per unit time of the relative positional relationship in a direction parallel to the substrate and the principle surface of the substrate of the nozzle.

[Claim 3]

A paste coating method in which a substrate is disposed on a table so that the substrate corresponds with a discharge outlet of a nozzle, a predetermined distance is maintained between the nozzle and the

substrate in a direction perpendicular to the principle surface of the substrate, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is changed while discharging paste filled into a paste container box from the discharge outlet onto the substrate, thus patterning the paste pattern of a predetermined shape on the substrate,

wherein while the paste pattern is patterned, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is detected, and when a location where the detected paste pattern is patterned is a place where a predetermined coating amount is changed, the coating amount is changed by varying the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate is changed.

[Claim 4]

A paste coating apparatus in which a substrate is disposed on a table so that the substrate corresponds with a discharge outlet of a nozzle, a predetermined distance is maintained between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is changed while discharging paste filled into a paste container box from the discharge outlet onto the substrate, thus patterning the paste pattern of a predetermined shape on the substrate, the apparatus comprising:

a storage means that stores data indicating the relationship

between the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, which corresponds to the coating amount of the paste pattern, and the relative position wherein the coating amount of the paste pattern will be changed between the substrate and the nozzle in a direction parallel to the principle surface of the substrate;

a detection means that detects the relative position between the substrate and the nozzle in a direction parallel to the principle surface of the substrate, in the paste pattern that is being patterned; and

a change means that changes the relative position between the substrate and the nozzle in a direction parallel to the principle surface of the substrate to the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, which corresponds to the coating amount of the paste pattern corresponding to its relative position, based on the data stored in the storage means, if the detection means detects the relative position, which is a relative position of which the coating amount of the paste pattern varies.

[Title of Invention] PASTE COATING METHOD AND THE PASTE COATING APPARATUS

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a paste coating method and a paste coating apparatus, wherein a substrate is disposed on a table so that the substrate corresponds with a discharge outlet of a

nozzle, a predetermined distance is maintained between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is changed while discharging paste filled into a paste container box from the discharge outlet onto the substrate, thus patterning the paste pattern of a predetermined shape on the substrate.

[0002]

[Description of the Prior Art] In a conventional paste coating apparatus, in order to control the coating amount, while paste filled into the container tank is discharged form the nozzle to the substrate, a relative distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate is controlled to have a predetermined value regardless of undulation of the principle surface of the substrate. Further, the coating amount is controlled by controlling a relative moving speed between the nozzle and the substrate, i.e., the speed when the paste pattern is coated (hereinafter, referred to as "coating velocity") or the pressure given to the paste container box that decides the discharge amount of paste from the nozzle (hereinafter, referred to as "coating pressure").

[0003] For example, in the case where the coating velocity is constant, when the discharge amount of paste increases, the coating pressure is raised. To the contrary, when the discharge amount of paste reduces, the discharge amount can be controlled through reduction of the coating

pressure. Further, in the event that the coating pressure is constant, when the discharge amount of paste increases, the coating velocity is reduced. To the contrary, when the discharge amount of paste shrinks, the discharge amount is controlled by increasing the coating velocity.

[0004]

[Problems to be Solved by the Invention] In the conventional paste coating apparatus, on the premise that the relative distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate is controlled to have a predetermined distance regardless of undulation of the principle surface of the substrate, the coating amount is controlled by adjusting the coating pressure or the coating velocity.

[0005] If it is desired to control the coating amount of paste through the coating pressure, a propagation time until the control results of the coating pressure is reflected from the front end of the nozzle to the discharge amount through the paste container box is required. Even between the times, the coating operation of the paste pattern is in progress according to the coating velocity. For this reason, it was difficult to abruptly control the coating amount.

[0006] As far as control of the coating amount of paste by the coating velocity concerned, the coating amount is frequently controlled at an ultra high speed using means for improving the productivity. Thus, if further high speed is performed, the coating amount of paste reduces. Thus, it was difficult to increase the coating velocity without changing the coating amount per unit distance.

[0007] Accordingly, the present invention has been made in view of the above problems, and it is an object of the present invention to provide the paste coating method and the paste coating apparatus in which the coating amount can be rapidly controlled and a paste pattern of a predetermined shape can be formed.

[0008]

[Means for Solving the Problem] In order to accomplish the object, according to the present invention, there is provided a paste coating method in which a substrate is disposed on a table so that the substrate corresponds with a discharge outlet of a nozzle, a predetermined distance is maintained between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is changed while discharging paste filled into a paste container box from the discharge outlet onto the substrate, thus patterning the paste pattern of a predetermined shape on the substrate. In this case, the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate is changed, and the paste having anamount proportional to the changed distance is discharged onto the substrate.

[0009] Further, in order to accomplish the object, according to the present invention, there is provided a paste coating apparatus in which a substrate is disposed on a table so that the substrate corresponds with a discharge outlet of a nozzle, a predetermined distance is maintained

between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, the relative positional relationship between the substrate and the nozzle in a direction parallel to the principle surface of the substrate is changed while discharging paste filled into a paste container box from the discharge outlet onto the substrate, thus patterning the paste pattern of a predetermined shape on the substrate. The apparatus includes storage means that stores data indicating the relationship between the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, which corresponds to the coating amount of the paste pattern, and the relative position wherein the coating amount of the paste pattern will be changed between the substrate and the nozzle in a direction parallel to the principle surface of the substrate, detection means that detects the relative position between the substrate and the nozzle in a direction parallel to the principle surface of the substrate, in the paste pattern that is being patterned, and change means that changes the relative position between the substrate and the nozzle in a direction parallel to the principle surface of the substrate to the distance between the nozzle and the substrate in a direction perpendicular to the principle surface of the substrate, which corresponds to the coating amount of the paste pattern corresponding to its relative position, based on the data stored in the storage means, if the detection means detects the relative position is a relative position where the coating amount of the paste pattern varies.

[0010]

[Embodiment of the Invention] The present invention will now be

described in detail in connection with preferred embodiments with reference to the accompanying drawings.

[0011] Fig. 1 is a perspective view illustrating a paste coating apparatus according to an embodiment of the present invention. In the drawing, reference numeral 1 indicates a stand, 2a and 2b indicate substrate return conveyers, 3 indicates a support pole, 4 indicates a substrate adsorption plate, 5 indicates a θ -axis moving table, 6a and 6b indicate X-axis moving tables, 7 indicates a Y-axis moving table, 8a and 8b indicate servomotors, 9 indicates a Z-axis moving table, 10 indicates a servomotor, 11 indicates a ball screw, 12 indicates a servomotor, 13 indicates a paste container box (syringe), 14 indicates a telemeter, 15 indicates a support plate, 16a and 16b indicate image recognition cameras, 17 indicates a controller, 18 indicates a monitor, 19 indicates a keyboard, 20 indicates a PC body having an external storage unit, and 21 indicates a cable.

[0012] In Fig. 1, two substrate return conveyers 2a and 2b are disposed on the stand 1 so that they are parallel to each other in the X-axis direction and can ascend and descend. The substrate return conveyers 2a and 2b return a substrate (not shown) from the inside to the front in the drawing, i.e., in a parallel manner in the X-axis direction. Further, the support pole 3 is disposed on the stand 1. The substrate adsorption plate 4 is disposed on the support pole 3 with the θ -axis moving table 5 therebetween. The θ -axis moving table 5 serves to rotate the substrate adsorption plate 4 in the θ direction being Z axis rotation.

[0013] Furthermore, the X-axis moving tables 6a and 6b are disposed on the stand 1 parallel to the X axis at an outer side than the substrate return

conveyers 2a and 2b. The Y-axis moving table 7 is disposed across the X-axis moving tables 6a and 6b. The Y-axis moving table 7 returns in a parallel manner in the X-axis direction according to rotation of forward rotation or backward rotation (forward and backward rotation) of the servomotors 8a and 8b disposed in the X-axis moving tables 6a and 6b. The Z-axis moving table 9 that moves in the Y-axis direction as the ball screw 11 rotates in the forward and backward rotation directions according to the driving of the servomotor 10 is disposed on the Y-axis moving table 7. The support plate 15 that supports and fixes the paste container box 13 or the telemeter part 14 is disposed on the Z-axis moving table 9. The servomotor 12 serves to the paste container box 13 or the telemeter part 14 in the Z-axis direction through a movable part of a linear guide (not shown) disposed on the support plate 15. The paste container box 13 is mounted in the movable part of the linear guide in such a way to be detached from the movable part. Further, the image recognition cameras 16a and 16b for positioning, etc. of a substrate (not shown) are disposed upwardly on a ceiling plate of the stand 1.

[0014] The controller 17 that controls the servomotors 8a, 8b, 10, 12 and 24 (not shown), etc. are located within the stand 1. The controller 17 is connected to the monitor 18 or the keyboard 19 and the PC body 20 through the cable 21. Data to be processed in the controller 17 are input from the keyboard 19, and an image captured by the image recognition cameras 16a and 16b or a processing situation in the controller 17 is displayed on the monitor 18.

[0015] Furthermore, data input from the keyboard 19 are stored in a

storage medium, such as a floppy disk, in the external storage unit of the PC body 20.

[0016] Fig. 2 is an enlarged perspective view of the paste container box 13 and the telemeter part 14 shown in Fig. 1. Reference numeral 13a indicates a nozzle, 22 indicates a substrate and 23 indicates a paste pattern. Like reference numerals are used to identify the same or similar parts as those of Fig. 1.

[0017] In Fig. 2, the telemeter part 14 has a triangular cut portion formed at its bottom, and a light-emitting device and a plurality of light-receiving elements disposed in the cut portion. The nozzle 13a is located under the cut portion of the telemeter part 14. The telemeter part 14 measures the distance from the front-end portion of the nozzle 13a to a surface (top surface) of the substrate 22 in a non-contact triangulation way. That is, the light-emitting device is disposed at an inclination plane at one side of the triangular cut portion. Laser light L radiated from the light-emitting device is reflected at a measurement point S on the substrate 22, and is incident on any one of the plurality of the light-receiving elements disposed on the inclined plane on the other side of the cut portion. Accordingly, the laser light L is not shielded by the paste container box 13 or the nozzle 13a.

[0018] Further, the measurement point S of the laser light L on the substrate 22 and a location immediately below the nozzle 13a are deviated by distances ΔX and ΔY on the substrate 22. Since there is no difference in undulation (depression and prominence) on the surface of the substrate 22 even between the location deviated by the distances ΔX

and Δ Y, a difference between the measurement results of the telemeter part 14 and the distances from the front end portion of the nozzle 13a and the surface of the substrate 22 does rarely exist. Accordingly, it is possible to maintain the distance from the front-end portion of the nozzle 13a to the surface of the substrate 22 to a desired value according to undulation on the surface of the substrate 22 by controlling the servomotor 12 based on the measurement result of the telemeter part 14.

[0019] Fig. 3 is a block diagram showing the construction of the controller 17, an air pressure controller of the paste container box 13 and the substrate controller 22 shown in Fig. 1. In the drawing, 17a indicates a microcomputer, 17b indicates a motor controller, 17c1 and 17c2 indicate X1 and X2-axis drivers, 17d indicates a Y-axis driver, 17e indicates a θ -axis driver, 17f indicates a Z-axis driver, 17g indicates a data communication bus, 17h indicates an external interface, 24 indicates a servomotor that drives the θ -axis moving table 5 (Fig. 1), 25 to 29 indicate encoders, 30 indicates a positive pressure source, 30a indicates a positive pressure regulator, 31 indicates a negative pressure source, 31a indicates a negative pressure regulator and 32 indicates a valve unit. Like reference numerals are used to identify the same or similar parts as those of Figs. 1 and 2.

[0020] In Fig. 3, the controller 17 has the microcomputer 17a or the motor controller 17b, the X-, Y-, Z- and θ -axis drivers 17c1 to 17f, an image processing apparatus 17i that processes image signals obtained from the image recognition cameras 16a and 16b, and the external interface 17h that performs signal transmission together with the

keyboard 19, etc. build in. The controller 17 further includes a driving control system of the substrate return conveyers 2a and 2b, which is not shown.

[0021] Further, the microcomputer 17a includes a main operation unit (not shown) or a ROM that stores a processing program for performing coating patterning of paste, which will be described later, a RAM that stores processing results in the main operation unit or input data from the external interface 17h and the motor controller 17b, an I/O unit that exchanges data with the external interface 17h or the motor controller 17b, and the like. The servomotors 8a, 8b, 10, 12 and 24 has the encoders 25 to 29, respectively. The servomotors 8a, 8b, 10, 12 and 24 perform positional control by returning the detection results to the X-, Y-, Z- and θ -axis drivers 17c1 to 17f.

[0022] If the servomotors 8a, 8b and 10 rotate in a forward or backward direction on the basis of data that are input from the keyboard 19 and then stored in the RAM of the microcomputer 17a, the nozzle 13a (Fig. 2) moves by a predetermined distance in the X and Y-axis direction through the Z-axis moving table 9 (Fig. 1), against the substrate 22 that is vacuum-adsorbed to the substrate adsorption plate 4 (Fig. 1) due to a negative pressure applied from the negative pressure source 131. During the movement, as the microcomputer 17a controls the valve unit 32, some air pressure is applied from the positive pressure source 30 to the paste container box 13 through the positive pressure regulator 30a and the valve unit 32. Thus, paste is discharged from the discharge outlet of the front-end portion of the nozzle 13a and is then coated on the substrate 22

in a desired pattern. While the Z-axis moving table 9 moves in parallel in the X and Y-axis direction, the telemeter part 14 measures the distance between the nozzle 13a and the substrate 22, and the servomotor 12 is controlled by the Z-axis driver 17f so that the distance always keeps constant.

[0023] Further, in a standby state where the paste is not coated, since the microcomputer 17a controls the valve unit 32, the negative pressure source 31 communicates with the paste container box 13 through the negative pressure regulator 31a and the valve unit 32, and the paste discharged from the discharge outlet of the nozzle 13a is retuned to the paste container box 13. It is thus possible to prevent paste from leaking from the discharge outlet. Further, the discharge outlet of the nozzle 13a is monitored by an image recognition camera (not shown). Thus, only when leakage is generated, the negative pressure source 31 can communicate with the paste container box 13.

[0024] Fig. 4 is a flowchart illustrating a paste coating method according to an embodiment of the present invention in the paste coating apparatus shown in Fig. 1.

[0025] In Fig. 4, if power is first applied to the paste coating apparatus (Step 100), initial setting is executed (Step 200).

[0026] In the initial setting, the Z-axis moving table 9 is moved in the X and Y direction by means of the servomotors 8a, 8b and 10 shown in Fig. 1 and is then positioned at a predetermined reference position, and a predetermined original point position is set so that the nozzle 13a (Fig. 2) is positioned at a location (i.e., a paste coating start point) where the paste

discharge outlet begins discharging paste. Furthermore, data of one or more paste patterns, (hereinafter, referred to as "paste pattern data", wherein the paste pattern data consist of a series of position data constituting a paste pattern coated on a real substrate), which are patterned on a substrate being a target paste pattern subject (hereinafter, referred to as "real substrate"), and coating condition data every paste pattern are input. The input of these data is carried out by through the keyboard 19 (Fig. 1), and the input data are stored in the RAM built in the microcomputer 17a (Fig. 3).

[0027] Assuming that paste patterns that are coated and patterned on one real substrate is m in number (where, m is an integer greater than 1) and the paste patterns are paste patterns of Pattern No.1, 2,......, m, as shown in Fig. 5, the coating condition includes data indicating the relative speed (this is referred to as "coating velocity", and in particular, the coating velocity in this case is referred to as "initial setting coating velocity") between the real substrate and the nozzle when the paste is actually coated on the real substrate every paste pattern, the pressure applied to the paste container box 13 that decides the paste discharge amount from the nozzle (this is referred to as "coating pressure", and in particular, the coating pressure in this case is referred to as "initial setting coating pressure"), the height of the nozzle from the surface of the substrate (this is referred to as "coating height", and in particular, the coating height in this case is referred to as "initial setting coating height"), a change point indicating a location (point) where the paste discharge amount will be changed, and the like. Furthermore, the change point is a

point that causes the height of the coating pattern high (or low) by increasing (decreasing) the paste coating amount, or change the paste discharge amount per time in order to coat the paste in the same height as the straight portion as in a curved portion of the pattern.

[0028] In this case, in each paste pattern, it is assumed that the change point is n in number (where, n is an integer greater than 0 or 1) and each change point is change points 1, 2,......, n. At this time, locations on the real substrate of the change points are a change point 1=(Xi1, Yi1), a change point 2=(Xi2, Yi2),......, a change point n=(Xin, Yin) with respect to the paste pattern of the pattern number i (where, i=1, 2,......, m). For example, in the case of the paste pattern of the pattern number 1, the change points are a change point 1=(X11, Y11), a change point 2=(X12, Y12),......, a change point n=(X1n, Y1n).

[0029] Further, coating height data are set to a change point, and locations other than the point. In Fig. 5, the coating heights 1 and 2 are set. The coating height 2 defines the coating height in the change points 1 to n, and the coating height 1 defines the coating height in other locations. Of course, in the case where the same coating height is maintained from one change point to the other change point, which have different coating heights between the change points, the coating height is set every between-change point. Position data of the change points 1 to n are any one of the paste pattern data. If the coating height varies at a predetermined region having a given length on the paste pattern, the entire position data in the region are set as the coating condition as the change point.

[0030] Further, though not shown in Fig. 5, in the coating condition, coating pattern moving data or a start point coordinate, a end coordinate, measured position data of a coated paste pattern, *** color pressure, and the like are also set.

[0031] If the initial setting (Step 200) is completed, the real substrate is mounted in the substrate adsorption plate 4 (Fig. 1) and then adsorbed thereto (Step 300). In mounting the substrate, the real substrate is moved upwardly from the substrate adsorption plate 4 in the X-axis direction by means of the substrate return conveyers 2a and 2b (Fig. 1). The real substrate is laid on the substrate adsorption plate 4 by descending the substrate return conveyers 2a and 2b through an elevation means (not shown).

[0032] Thereafter, preliminary positional decision of the substrate is performed (Step 400). In this process, the real substrate is positioned in the X and Y direction by means of a positional decision chuck (which is not shown in Fig. 1). Further, a positional decision mark of the real substrate mounted in the substrate adsorption plate 4 is taken by the image recognition cameras 16a and 16b. The image of the centroid position of the positional decision mark is processed to detect a tilt in the θ direction of the real substrate. The tilt of the θ direction is corrected by means of the servomotor 24 (Fig. 3) based on the detected tilt.

[0033] Further, in the case where there is a possibility that the paste may be short of during the coating operation of the paste pattern since the amount of the paste that remains within the paste container box 13 reduces, the paste container box 13 is previously exchanged with the

nozzle 13a. When the nozzle 13a is exchanged, there occurs positional deviation in the mounting position compared to before-the exchanged. This may cause reappearance to degrade. Accordingly, in order to secure reappearance, a place where paste is not coated on the real substrate is coated with paste in a cross shape using a new nozzle 13a. A centroid position of the cross-shaped coating pattern is then found through image process. A distance between the obtained centroid position and a centroid position of a positional decision mark on a real substrate is calculated. The distance is stored in the RAM built in the microcomputer 17a as positional deviation amounts dx and dy (Fig. 2) of the paste discharge outlet of the nozzle 13a.

[0034] The above is substrate preliminary positional decision for the real substrate (Step 400). Positional deviation of the nozzle 13a in coating patterning of a paste pattern, which is performed later, is corrected using the positional deviation amounts dx and dy of the nozzle 13a

[0035] Thereafter, a paste pattern is sequentially coated beginning from paste pattern data of Pattern No.1 (Step 500). This will be described in detail with reference to Fig. 6.

[0036] In Fig. 6, a coating condition is first set (Step 501). In this case, the RAM of the microcomputer 17a (Fig. 3) includes a storage table in which paste pattern data of each paste pattern and a coating condition as shown in Fig. 5 are stored. In step 501, paste pattern data of a paste pattern to be coated and a coating condition are read from the storage table, and are then stored in a predetermined region of the RAM so that they can be used in the microcomputer 17a. In this case,

since the paste pattern of Pattern No.1 is coated and patterned, in the coating condition in this case, the coating velocity=V1, the coating pressure=P1, the coating height 1=H11, the coating height 2=H12, the change point coordinate 1=(X11, Y11), the change point coordinate 2=(X12, Y12),......, the change point coordinate n=(X1n, Y1n) are read from the storage table and then stored in a predetermined region of the RAM so that they can be used in the microcomputer 17a, according to the table shown in Fig. 5.

[0037] If the coating condition is fully set, the servomotors 8a, 8b and 10 (Fig. 1) are driven to move the nozzle 13a on a patterning (coating) start point (Step 502). In order to position the discharge outlet of the nozzle 13a at the coating start location, the Z-axis moving table 9 (Fig. 1) is moved, and the position of the nozzle is then compared, controlled and moved. To do this, it is determined whether the positional deviation amounts dx and dy of the nozzle 13a, which are obtained in previous substrate preliminary positional decision step (Step 400 in Fig. 4) and then stored in the RAM of the microcomputer 17a, fall within the tolerance △X and □Y of the positional deviation amount of the nozzle 13a shown in Fig. 2 R>2. If the positional deviation amounts dx and dy fall within the tolerance (i.e., □X≥ dx and △Y≥ dy), the discharge outlet keeps intact. If the positional deviation amounts dx and dy exceeds the tolerance (i.e., □X≥ dx and △Y ≥ dy), the Z-axis moving table 9 is moved based on the positional deviation amounts dx and dy, and controls the paste container box 13. Position deviation between the paste discharge outlet of the nozzle 13a and a desired position of the real substrate is corrected, so that the nozzle

13a can be positioned at the desired position.

[0038] Next, the servomotor 12 (Fig. 1) is driven and the height of the nozzle 13a is set (Step 503). The set height is a coating height 1 (more particularly, the height H11 of Fig. 5), which is set according to the coating condition of Pattern No.1 read from the storage table of the RAM. The distance from the discharge outlet of the nozzle 13a to the surface of the real substrate is set to the coating height H11.

[0039] If the above process is completed, the servomotors 8a, 8b and 10 (Fig. 1) are driven based on the paste pattern data stored in the RAM of the microcomputer 17a. In a state where the paste discharge outlet of the nozzle 13a is opposite to the real substrate, the paste discharge outlet moves in the X and Y direction according to the paste pattern data (Step 504). Further, the air pressure that is set to the coating pressure P1 in the coating condition of Pattern No.1 is applied from the positive pressure source 30 (Fig. 3) to the paste container box 13 through the valve unit 32 (Fig. 3) by the positive pressure regulator 30a (Fig. 3), so that the paste begins discharging from the paste discharge outlet of the nozzle 13a (Step 505). At this time, immediately before the discharge of the paste, a negative pressure that is set to the *** color pressure is applied from the negative pressure source 31 (Fig. 3) to the paste container box 13 through the valve unit 32 (Fig. 3) by means of the negative pressure regulator 31a (Fig. 3) for some time. If the paste gathering at the paste discharge outlet of the nozzle 13a is sucked, the paste can be coated so that it does not gather at the start end.

[0040] Together with the start of the coating patterning operation, the

microcomputer 17a receives actually measured data of the distance between the paste discharge outlet of the nozzle 13a and the surface of the real substrate from the telemeter part 14, and measures undulation on the surface of the real substrate based on the received data. The microcomputer 17a then drive the servomotor 12 based on the measured value. Thus, the height of the nozzle 13a, which is set from the surface of the real substrate, becomes constant, i.e., the coating height 1 in the coating condition of Pattern No.1, as shown in Fig. 7(a), and coating patterning of the paste pattern is then performed (Step 506).

[0041] Further, the microcomputer 17a reads a coating location of the paste pattern on the real substrate, i.e., a coordinates from the motor controller 17b (Step 507), and then determines whether it has reaches the change point 1(X11, Y11) in the coating condition of Pattern No.1 (Step 508).

[0042] If it is determined that the change point 1 is reached, the microcomputer 17a changes the distance between the paste coating surface of the real substrate and the nozzle from the coating height1=H11 of the coating condition of Pattern No.1 to the coating height2=H12 (Step 509). This is performed as the servomotor 12 drives. Fig. 7(b) shows a state in the change point 1, where H11 > H12. In the case where the distance is the change point 1, 2,......, coating patterning of the paste pattern is executed while the coating height2=H12 is set.

[0043] In this case, as shown in Fig. 7(b), at a change point where the coating height becomes low, if there is no change in the coating velocity and the coating pressure, the paste discharged from the nozzle 13a has

increased discharge resistance with the help of reaction from the real substrate. It becomes difficult for the paste to be discharged from the nozzle 13a. The coating amount of the paste is reduced as much as the coating height is lowered. To the contrary, if the coating height2=H12 becomes higher than the coating height1=H11, reaction from the real substrate becomes small and discharge resistance is lowered because the nozzle 13a drops to the real substrate. For this reason, the paste is likely to be discharged from the nozzle 13a and the coating amount of the paste increases accordingly. Thus, the relationship between values such as the coating velocity, the coating pressure, the coating height1 and the coating height2 and the positional coordinate of the change point is set according to the coating condition shown in Fig. 5, and is then stored in the storage table of the RAM of the microcomputer 17a. It is thus possible to control the coating amount of the paste at a predetermined location of the paste pattern, accordingly, the coating height of the paste on the real substrate.

[0044] By doing so, coating patterning of the paste pattern is performed. Whether to proceed the coating patterning operation of the paste pattern is decided according to whether the coating point is the end of a paste pattern to be coated, which will be decided by the paste pattern data (Step 510). If it is determined that the coating point is not the end, the process returns to the process of measuring surface undulation of the real substrate, i.e., control of the coating height (Step 506). The coordinate continues to be confirmed (Step 507). Then, whenever the change point is reached, the coating height is changed, and continues to be changed until the change point.

[0045] Hereafter, the respective processes are repeated. If the change point reaches the coating end of the paste pattern, the application of the air pressure, which is applied from the positive pressure source 30 (Fig. 3) to the paste container box 13 through the valve unit 32 (Fig. 3) and is set to the coating pressure P1 to, is stopped by means of the positive pressure regulator 30a (Fig. 3). The discharge of the paste from the paste discharge outlet of the nozzle 13a is thus stopped (Step 511).

[0046] The coating operation of the paste pattern is carried out until the whole m number of the paste pattern data is ended (Step 512). If the end of the paste pattern of the last Pattern No.m is reached, the servomotor 12 is driven to raise the nozzle 13a, and the pattern patterning operation, i.e., pattern coating (Step 500) is thus completed.

[0047] Thereafter, in Fig. 4, the process returns to a substrate step (Step 600). In Fig. 1, adsorption of the real substrate to the substrate adsorption plate 4 is released and the substrate return conveyers 2a and 2b are raised to raise the real substrate 22. In this state, the substrate return conveyers 2a and 2b are discharged by the substrate return conveyers 2a and 2b. Further, it is determined whether the entire process has been completed (Step 700). In the event that a paste pattern is coated and patterned using paste pattern data such as plural sheets of the real substrate, the substrate is mounted in each of the real substrates (Step 300). Further, if a series of the processes are performed on all the real substrates, the work is all completed (Step 800).

[0048] Although the present invention has been described in conjunction with the embodiments, the present invention is not limited to them.

[0049] That is, in the aforementioned embodiment, it has been described that the nozzle is driven and the substrate is fixed. It is however to be noted that the nozzle can be fixed and the substrate can be moved.

[0050] Further, even in the case where the coating velocity is slow in the curved portion of the paste pattern, the coating amount of paste can be reduced by lowering the coating height at the low range. It is thus possible to make constant the coating amount of paste per time over the entire paste pattern and also possible to coat the paste pattern of a predetermined shape with high accuracy.

[0051] Further, if the coating height becomes high and the coating velocity becomes high by making constant the coating pressure, the coating amount of paste per unit distance is not changed and a line width of a paste pattern becomes constant. It is not necessary to control a coating pressure having bad response during patterning. The coating patterning time of a desired paste pattern can be shortened while maintaining high reliability by a combination of the coating height and the coating velocity. It is therefore possible to increase the productivity.

[0052]

[Effect of the Invention] As described above, according to the present invention, since the coating amount can be readily controlled rapidly, a paste pattern of a predetermined shape can be formed with high accuracy.

[Description of Drawings]

[Fig. 1] Fig. 1 is a perspective view illustrating a paste coating apparatus according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is an enlarged perspective view of a paste container box

and the telemeter part shown in Fig. 1.

[Fig. 3] Fig. 3 is a block diagram showing the construction of a controller, an air pressure controller of a paste container box and the substrate controller shown in Fig. 1.

[Fig. 4] Fig. 4 is a flowchart illustrating a paste coating method according to an embodiment of the present invention in the paste coating apparatus shown in Fig. 1.

[Fig. 5] Fig. 5 is a view showing a detailed example of a coating condition set Step 200 in Fig. 4.

[Fig. 6] Fig. 6 is a flowchart illustrating the details of Step 500 of Fig. 4.

[Fig. 7] Fig. 7 is a view showing variation in the coating amount of paste against variation in the coating height when the coating pressure is constant.

[Description of Numerals]

13a: Nozzle

22: Substrate

23: Paste pattern